Significance of geometrical relationships between low-temperature intracrystalline deformation microstructures in naturally deformed quartz

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Although quartz is one of the most studied minerals in the Earth's crust when it comes to its rheology, the interpretation of intracrystalline deformation microstructures with respect to deformation conditions and mechanisms, remains highly contentious. Moreover, inconsistent use of terminology for both deformation microstructures and mechanisms makes a correct assessment of observations and interpretations in published material very difficult. With respect to low-temperature intracrystalline deformation microstructures in quartz, different conflicting genetic models have been proposed. Most probably, the lack of consensus means that there is no unique interpretation for these microstructures, primarily because their initiation and development depend on many ambient conditions.

We extensively studied these intracrystalline deformation microstructures by means of optical microscopy, Hot-Cathodoluminescence, SEM-Cathodoluminescence and Electron Backscatter Diffraction Orientation Imaging, in vein quartz of the High-Ardenne slate belt (Belgium, France, Luxemburg, Germany), (de)formed in a low-temperature regime.

Firstly, we propose a new, purely descriptive terminology for the low-temperature intracrystalline deformation microstructures in naturally deformed quartz: fine extinction bands (FEB), wide extinction bands (WEB) and strings. The strings can be further subdivided into blocky (BS), straight (SS) and recrystallised (RS) morphological types. FEBs have consistently been called deformation lamellae in quartz and planar slip bands in metals. WEBs have been called deformation bands, prismatic kink bands or type II kink bands. Strings have formerly been called shear bands, deformation bands or type I kink bands. No distinction between blocky and straight morphological string types had ever been made.

Secondly, a survey of the pre-recrystallisation stages in the history of the intracrystalline deformation microstructures reveals that the different types of low-temperature intracrystalline deformation microstructures in naturally deformed vein quartz show particular geometrical relationships, in our opinion a to date underexposed aspect of these microstructures. Several of these geometrical relationships will be presented and their potential implications with respect to deformation mechanisms and conditions will be discussed. The geometrical relationships observed may suggest a similar formation mechanism for the different microstructures, a weakening effect for successive microstructure formation and a strong dependency on the crystallographic orientation.